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1 **Title:**

2 **Trial of labor after cesarean and contribution of pelvimetry in the prognosis of neonatal**
3 **morbidity**

4

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15

16

17 **Abstract**

18

19 **Introduction :** To estimate the association between an abnormal pelvic dimension at
20 pelvimetry and the occurrence of severe neonatal morbidity after trial of labor after cesarean
21 (TOLAC).

22 **Materials and Methods:** Retrospective observational cases-controls study conducted at a
23 level 3 maternity units between 2006 and 2016. Included women were patient with trial of
24 labor after one previous cesarean section, alive singleton fetus in cephalic presentation ≥ 37
25 WG. Two groups were compared according to pelvic measures at pelvimetry: pelvic dimension
26 considered as abnormal, defined by Conjugate Diameter <10.5 cm and/or Transverse
27 Diameter <12 cm and pelvic dimension considered as normal for other women. The primary
28 outcome was a composite criterion of neonatal morbidity and mortality. A logistic
29 multivariate regression model was use to estimate the association between an abnormal pelvic
30 dimension at pelvimetry and the occurrence of severe neonatal morbidity

31 **Results:** 2474 women were included. 863 (34.8%) have a normal pelvic dimension and 1611
32 (65.2%) an abnormal. Characteristics of labor were similar in two groups. Success of
33 TOLAC was 84.7% in normal pelvic group and 64.6% in abnormal dimension of pelvic
34 group. Neonatal morbidity was similar between two groups (1.7% in normal pelvic dimension
35 group versus 2.3% in abnormal pelvic dimension group, $p = 0.26$; crude OR: 1.39 (0.77-
36 2.49) ; adjusted OR : 0.93 (0.51-1.68)).

37 **Discussion:** There were no association between pelvic dimension at pelvimetry and neonatal
38 morbidity. In case of abnormal pelvic dimension, a combination of more prudence, and
39 stringent user practices, achieve a high rate of vaginal delivery and a neonatal morbidity
40 comparable to the normal pelvic dimension group.

41

42 **Key-words :** Neonatal morbidity, Pelvimetry, Previous cesarean, Trial of labor after cesarean
43 section (TOLAC)

44

45 **Introduction :**

46 We observe an increase rate of women with previous cesarean delivery over the world [1,2,3].
47 In France the rate of pregnant women with a history of cesarean delivery was 15.6% in 2010,
48 and 16.2% in 2016 [2]. For the labor management of women with previous cesarean delivery,
49 practionner can propose a planned iterative cesarean delivery or a planned vaginal delivery
50 [4]. The main feared complication of trial of labor after cesarean (TOLAC) is the occurrence
51 of uterine rupture because it is associated with an increased risk of maternal and neonatal
52 morbi-mortality [5,6]. Guidelines of developed countries encouraged TOLAC, because
53 cesarean delivery is associated with more neonatal and maternal complications at short and
54 long term, that increase with the number of cesareans, and because the risk of uterine rupture
55 is very sparse [7–10]. In case of previous cesarean, pelvimetry was studied for choosing the
56 mode of delivery, predicting the success of TOLAC and the occurrence of uterine rupture
57 [11]. Due to the absence of contribution of pelvimetry for decrease the failure of TOLAC and
58 for predict uterine rupture, the National College of French Gynecologists and Obstetricians
59 (CNGOF) conclude that the pelvimetry is not necessary for choosing the mode of delivery in
60 case of previous cesarean [4]. Despite these guidelines, actually in France, some practitioners
61 realize pelvimetry in case of previous cesarean, but the estimation of this practice was
62 difficult to determine. One study limited to the Northeast region estimated this practice at
63 44% of maternity units [11]. For practitioners maintaining the pelvimetry, it is not for
64 performing a planned cesarean delivery in case of abnormal dimension but for managing the
65 TOLAC according to the pelvic dimension associated with others clinical data (indication of
66 previous cesarean, estimated fetal weight, cervical dilatation...). Use of pelvimetry has been
67 poorly studied in case of TOLAC to evaluate its contribution in the management of labor and
68 in the neonatal prognosis.

69 The objective of this study was to estimate the association between an abnormal pelvic
70 dimension at pelvimetry and the occurrence of severe neonatal morbidity after TOLAC.

71

72 **Materials and Methods:**

73 It was a retrospective observational case-control study conducted at a level 3 maternity unit
74 between 2006 to 2016. The entire medical file was computerized and was completed
75 prospectively at each visit, at delivery, and during the post partum period. All data were
76 verified at the obstetrics staff meeting the day after the delivery. Inclusion criteria were
77 history of one previous cesarean delivery, with a planned vaginal delivery, with alive
78 singleton in cephalic presentation at or before 37 gestational age. Women were excluded if
79 they had two or more previous cesareans, an in utero fetal death before labor, a termination of
80 pregnancy, a fetal malformation, presentations other than cephalic, multiple pregnancies,
81 planned cesarean delivery. Women with missing data for the pelvimetry or the neonatal
82 outcomes were excluded.

83

84 We defined two study groups according to the pelvimetry : “ pelvic dimension at pelvimetry
85 considered as abnormal” defined by a transverse diameter (TD) < 12 cm, and/or conjugate
86 diameter (CD) < 10.5 cm ; and “normal pelvic dimension at pelvimetry” for the other women.
87 These cut offs were chosen because they are the usual cut off utilized [12-14].

88

89 All women with a previous cesarean whom delivered at this maternity, having a pelvimetry.
90 The planned mode of delivery was discussed during the third trimester in meeting staff with
91 the obstetrical team about obstetrical history, pelvimetry and estimated fetal weight. None
92 cesarean delivery decision before labour was given on the pelvic components except for the
93 pelvis, which was considered very abnormal (transverse diameter < 10.5 cm, and/or conjugate

94 diameter < 9.5 cm) [12-14]. Labor could be spontaneous, or induced in case of medical
95 indication. There were no indication for cesarean delivery due to the absence of pelvimetry.
96 The use of oxytocine during labor was possible for medical indication. An arrest of labour at
97 two hours was authorized in case of uterine hypotonic dysfunction, beyond cesarean delivery
98 was recommanded. Internal tocometry was not used in this maternity unit, but to appreciate
99 uterin dynamic the use of an uterine palpation and vaginal examination was realized. In this
100 department, a routine manual uterine examination after delivery was performed to ensure the
101 integrity of the uterine scar. A uterine rupture was defined by complete rupture of the
102 myometrium and serosa. In case of uterine rupture, surgical revision by laparotomy was
103 considered only in cases of postpartum hemorrhage.

104

105 We collected the following data: the mothers' characteristics, any disease or disorders
106 occurring during pregnancy, characteristics of labor and delivery, any complications of
107 delivery, and neonatal characteristics.

108

109 The principal endpoint was a composite neonatal criterion, including at least one of following
110 items: per partum or neonatal death defined as death within 28 days after birth, hypoxic
111 ischemic encephalopathy defined as cerebral anomalies due to neonatal asphyxia (umbilical
112 pH < 7.0), Apgar score less than 4 at 5 min, endotracheal tube for more than 24h within 72h
113 after birth, or a proven neonatal sepsis defined as a positive hemoculture in the absence of any
114 other recognized etiology.

115 The secondary endpoint was the occurrence of uterine rupture.

116

117 Neonatal medical records were reviewed individually and completely for newborn's death,
118 admitted to the NICU or neonatology unit.

119

120 We compared the characteristics of two groups based on Pearson's χ^2 test or Fisher exact test
121 for categorical variables, and Student t-test or Wilcoxon-Mann-Whitney test for quantitative
122 variables, as appropriate. Statistical significance was set at a two-tailed value of P.05. The
123 association between pelvic dimension at pelvimetry and severe neonatal morbidity was
124 analyzed with multivariable logistic regression. Causal assumptions between pelvic
125 dimension at pelvimetry, severe neonatal morbidity, and covariates were represented with a
126 directed acyclic graph to depict the exposure-outcome relations with confounding and
127 intermediate factors (data not shown) for helping to select variables that are confounders (ie,
128 variables associated with both the exposure and the outcome) and those that do not qualify as
129 confounders (especially intermediate factors) [15]. The main regression model included only
130 the strict confounder: intra uterine growth restriction (IUGR).

131

132 The analyses were performed with Stata software version 13.0.

133 This database was approved by the National Data Protection Authority (Commission
134 Nationale de l'Informatique et des Libertés, CNIL no. 293683). Under French regulations,
135 this study was exempt from Institutional Review Board approval because it was an
136 observational study using anonymized data from medical records. Women were informed that
137 their records could be used for the evaluation of medical practices and were allowed to opt out
138 of these studies.

139

140 **Results :**

141 This study included 3083 women with a previous cesarean and with alive singleton in
142 cephalic presentation at or after 37 gestational age (GA). We excluded 54 (1.7%) women with
143 a fetus with a congenital malformation and 208 (6.7%) with planned cesarean delivery. Data

144 for pelvimetry were missing for 270 (8.7%) women, and neonatal data were missing for 77
145 (2.5%) newborn (Figure 2). Thus, 2474 women were included in this analysis.

146 Among included women, 1611 (65%) having a normal pelvic dimension at pelvimetry and
147 863 (35%) an abnormal dimension. Transverse diameter was less than 12 cm for 771 (31,2%)
148 women, whose 418 (16,9%) with a transverse diameter less than 11,5 cm. Conjugate diameter
149 was less than 10,5cm for 252 (10,2%) women, whose 70 (2,8%) with a conjugate diameter
150 less than 10 cm. Among women with abnormal dimension, 160/863 (18.5%) women had
151 both a transverse diameter < 12 and a conjugate diameter <10.5.

152
153 Compared with women with normal pelvic dimension at pelvimetry, women with abnormal
154 pelvic dimension were more statistically younger (32.9 years vs 33.5 years; $p = 0.01$) and
155 have less weight gain during pregnancy (10.3 kg vs 11.2 kg; $p < 0.01$), without these
156 differences were clinically pertinent. There was no difference between the two groups for
157 body mass index and parity.

158 Compared with women with normal pelvic dimension at pelvimetry, women with abnormal
159 pelvic dimension have less previous vaginal birth after cesarean delivery (23.4% vs 28.6%; p
160 < 0.01), more gestational hypertensive pathology (5% vs 3%; $p = 0.01$) and more suspected
161 IUGR (1.6% vs 0.7% $p=0.02$) (Table 1).

162 No significant difference was found between the two groups regarding delivery term, onset of
163 labor, methods of labor induction, analgesia, duration of labor and use of oxytocin during
164 labor (Table 2).

165 Compared with women with normal pelvic dimension at pelvimetry, women with abnormal
166 pelvic dimension have more cesarean delivery during labor (35.3% vs 15.2%; $p < 0.01$).

167 The rate of abnormal fetal heart rate (FHR), requiring cesarean delivery or instrumental
168 delivery, was higher in abnormal pelvic dimension group.

169 No significant difference was found between the two groups regarding uterine dehiscence,
170 uterine rupture, and postpartum hemorrhage. There was no maternal death.

171 In abnormal pelvic dimension at pelvimetry group, 8 uterine ruptures occurs (0.8%). In
172 normal pelvic dimension at pelvimetry group, 10 uterine ruptures occurs (0.6%). Among the
173 18 uterine ruptures, 16 had an emergency cesarean for suspected uterine rupture and two had
174 instrumental vaginal delivery for abnormal FHR and the diagnostic of uterine rupture was
175 realized during the manual uterine examination and was required a surgery for post partum
176 hemorrhage.

177 Neonatal morbidity was similar between the two groups (2.3% versus 1.7%, $p = 0.26$; crude
178 OR : 1.39 (0.77-2.49) ; adjusted OR: 0.93 (0.51-1.68)) (Table 4).

179 In abnormal pelvic dimension at pelvimetry group, one neonatal death occurs due to hypoxic
180 ischemic encephalopathy within 2 days after birth. It was an emergency cesarean delivery due
181 to uterine rupture. In normal pelvic dimension at pelvimetry group, one neonatal death occurs
182 due to hypoxic ischemic encephalopathy after cardiac failure (dilated cardiomyopathy). It was
183 not detected on antenatal sonography. In the same group, the second cases with hypoxic
184 ischemic encephalopathy was due to respiratory distress (endotracheal tube for more than 24h
185 within 72h after birth) after an emergency cesarean for uterine rupture.

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190 **Discussion :**

191 Based on this population of women with trial of labor after one previous cesarean delivery,
192 we showed that abnormal pelvic dimension at pelvimetry was not associated with an
193 increased neonatal morbidity.

194

195 Our study has some strenghts. Data were valid and exhaustive because they were collected
196 prospectively through computer software used by all medical staff and verified every morning
197 during collegial meeting, and for severe events such as uterine rupture, and neonatal
198 morbidity, all medical record were analyzed. We used a severe composite neonatal criteria
199 approved in many studies [16,17]. This primary outcome is pragmatic and logical, and it has
200 good external validity. Due to the unicentric characteristic of this study, obstetrical practices
201 were uniform in the management of patients during labor, for prenatal care and for the
202 decision of cesarean.

203

204 Extrapolation of our results is limited since the study was conducted in a single center,
205 realizing more than three thousands of delivery by year with a cesarean delivery rate lower
206 than nationally rate. A limitation of this study was the pelvimetry cut-off value to define
207 “abnormal pelvic”. These cut-offs, although in common use, may have some limitations.
208 Their determinations are old, and little documented. With stricter limit value, we would have
209 decrease number of cases, and decrease study strength. Nevertheless it was pelvimetry cut-off
210 value frequently used in French maternity [18].

211

212 The approach of this study was descriptive for having pragmatic results, and not explicative.
213 Some hypothesis could have suggested a negative impact on neonatal outcomes of abnormal
214 pelvic dimension. Duration of labor more longer, abnormal FHR more frequent and

215 instrumental vaginal delivery more complex are feared in case of trial of labor and abnormal
216 pelvic dimension, with in case of obstetrical complications, a possible neonatal resounding.
217 This was not found in our study not showing any difference in neonatal outcome according to
218 pelvic dimension. It was an original result because it is the first study analyzing the
219 association between dimension of pelvis and neonatal morbidity. Previously, some studies
220 analyzed maternal outcomes (like uterine rupture) and obstetrical outcomes (like the rate of
221 cesarean delivery) in case of TOLAC. An impact of pelvic dimension on neonatal morbidity
222 would have been interesting to adapt pediatric management at the birth and prevent some
223 critical situations.

224

225 Although the neonatal morbidity was similar in two groups of pelvic dimension, we found
226 more abnormal FHR in abnormal pelvic dimension group. This could be explained by a
227 different fetal head compression during its confrontation with the maternal pelvis during
228 uterine contractions and expulsive efforts. Despite this abnormal FHR, neonatal morbidity
229 was similar. It is possible that this is due to increased vigilance of the team who intervene
230 quickly during labor for abnormal FHR or arrest of cervical dilatation, because of the
231 knowledge of the pelvic dimension.

232

233 In accordance with literature, we showed that cesarean delivery rate was higher in case of
234 abnormal pelvic dimension [13,19]. Due to the observational design of this study, an
235 indication bias could not be excluded and explained this increased rate of cesarean delivery in
236 the group of women with abnormal pelvic dimension. Indeed, all practitioners know the
237 pelvic dimension, which may have influenced their decisions to realize a cesarean delivery for
238 less strict indications in abnormal pelvic dimension group. However, global cesarean delivery
239 rate in our study (22%) was lower than many studies (from 20 to 40%) [7,9]. It is fair to

240 confirm, in accordance with French guidelines, that pelvimetry should not have to use in
241 planning mode of delivery. Thus the practice of pelvimetry does not necessarily cause an
242 increased rate of cesarean delivery. The practice of such a complementary examination must
243 be considered and the results adapted. The fear of increasing the rate of cesarean delivery
244 because of the only realization of the pelvimetry does not seem to justify and is questioned.

245 The rate of uterine rupture was low (0.7%), similar with results of literature [20,21]. In this
246 study, uterine rupture was not associated with pelvic dimension, but it was not the main
247 endpoint and the power of this study is smaller to highlight a difference concerning the
248 occurrence of such a rare event.

249 In conclusion, there was no association between pelvic dimension at pelvimetry and neonatal
250 morbidity. This result does not question the recommendation on the pelvimetry for women
251 with previous cesarean delivery, and obstetrical team realizing pelvimetry for this indication
252 will probably continue its practice. For women with abnormal pelvic dimension, a
253 combination of more prudence, and stringent user practices, can allow to achieve a high rate
254 of vaginal delivery and a neonatal morbidity comparable to the normal pelvic dimension
255 group. A further study, on the specific contribution of pelvimetry in the management of labor
256 in case of TOLAC, cannot be conducted by a retrospective design, should be conducted
257 prospectively.

258
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262 **Authors contribution:** NR contributions were the acquisition of data, analysis and
263 interpretation of data, drafting the article and final approval of the version to be submitted.

264 DK contributions were the conception and design of the study, analysis and interpretation of
265 data, drafting the article and final approval of the version to be submitted. CM contributions
266 were the analysis and interpretation of data, revising the article critically for important
267 intellectual content, and final approval of the version to be submitted. OS contributions were
268 the conception and design of the study, analysis and interpretation of data, revising the article
269 critically for important intellectual content, and final approval of the version to be submitted.

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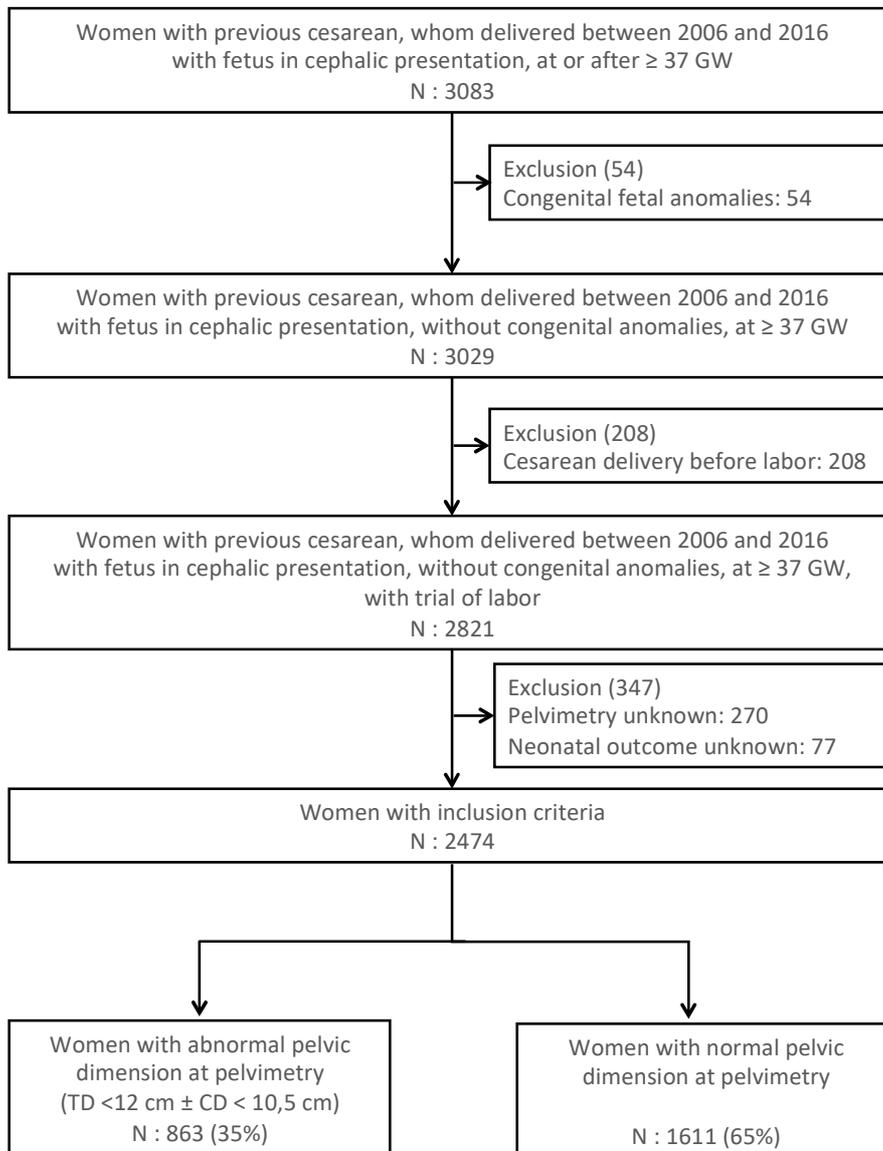
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338 **Figure 1 : Flow Chart**



343 **Table 1: Maternal and obstetrical characteristics**

	Abnormal pelvic dimension at pelvimetry n=863 N (%)	Normal pelvic dimension at pelvimetry n=1611 N (%)	p
Maternal age (mean ± SD)	32.9 ± 5.1	33.5 ± 5	0.01
< 30	252 (29.2)	426 (26.4)	0.04
(30-39)	546 (63.3)	1019(63.3)	
≥ 40	65 (7.5)	166 (10.3)	
Body mass index	25.4±5.3	25.2±5.37	0.24
< 18.5	37 (4.3)	89 (5.5)	
(18.5-24)	363 (42.1)	696 (43.2)	
(25-29)	248 (28.6)	431 (26.8)	
≥ 30	151 (17.5)	295 (18.3)	
Weight gain (mean ± SD)	10.3±6.1	11.2±5.9	< 0.01
Previous medical conditions			
Hypertensive pathology	30 (3.5)	55 (3.4)	0.93
Preexisting diabetes at pregnancy	13 (1.5)	29 (1.8)	0.59
Parity			0.59
2	512 (60.0)	929 (58.0)	
≥ 3	351 (40.0)	682 (42.0)	
Previous pregnancy-related disease			
Gestational hypertensive pathology	64 (7.0)	141 (9.0)	0.25
Gestational diabetes	53 (6.1)	112 (7.0)	0.44
Shoulder dystocia	24 (2.8)	29 (1.8)	0.10
Vaginal delivery after cesarean delivery	202 (23.4)	460 (28.6)	0.006
Pregnancy-related disease			
Gestational hypertensive pathology	46 (5.0)	52 (3.0)	0.01
Gestational diabetes	70 (8.1)	120 (7.4)	0.55
Preterm labour	22 (2.5)	44 (2.7)	0.79
Premature ruptur of membranes	3 (0.3)	2 (0.1)	0.23
Suspected IUGR	14 (1.6)	11 (0.7)	0.02

344 SD : standard deviation

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369 **Table 2: Labor characteristics**

	Abnormal pelvic dimension at pelvimetry n = 863 N (%)	Normal pelvic dimension at pelvimetry n = 1611 N (%)	p
Gestational age at delivery			0.11
(37-38)	155 (18.0)	303 (18.8)	
(39-40)	525 (60.8)	911 (56.5)	
41	156 (18.1)	324 (20.1)	
≥ 42	27 (3.1)	73 (4.5)	
Spontaneous labour	656 (76.0)	1199 (74.4)	0.38
Induced labour	207 (24.0)	412 (25.6)	
Oxytocine	57 (27.0)	94 (23.0)	0.15
Intracervical prostaglandin	150 (73.0)	318 (77.0)	
Intracervical prostaglandin and misoprostol	9 (7.0)	48 (15.0)	0.08
Peridural analgesia	785 (91.0)	1434 (89)	0.12
Artificial rupture of membranes	432 (50.1)	797 (49.5)	0.37
Labour duration (min) (mean ± SD)	380 ± 216	369 ± 208	0.28
Median (Q1-Q3)	374 (223-516)	350 (287-507.5)	
Use of oxytocine	516 (59.8)	948 (58.8)	0.80
Max dose (median (Q1-Q3))	40 (20-60)	40 (20-50)	0.75
Duration (min) mean+/-SD	51 ±100	45 ±103	0.17
Arrest of labour	145 (16.8)	286(17.8)	0.55
Clinical estimated fetal weight (mean ± SD)	3374 ± 369	3393 ± 384	0.23

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Table 3: Delivery characteristics

	Abnormal pelvic dimension at pelvimetry n = 863 N (%)	Normal pelvic dimension at pelvimetry n = 1611 N (%)	p
Mode of delivery			<0.001
Cesarean	305 (35.3)	245 (15.2)	
Vaginal delivery	558 (64.7)	1366 (84.8)	
Cesarean			0.26
Indication			
Fetal*	118 (38.6)	107 (43.6)	
Maternal**	6 (0.6)	8 (3.4)	
Obstetrical***	181 (59.3)	130 (53.0)	
Vaginal delivery			0.97
Spontaneous	366 (66.0)	905 (66.0)	
Instrumental	192 (34.0)	461 (34.0)	
Indication			<0.001
FHR anomalies	142 (74.0)	260 (57.0)	
Default of progression	50 (26.0)	201 (43.0)	
Shoulder dystocia	10 (1.2)	8 (0.5)	0.06
Uterine scar			
Dehiscence scar	20 (2.3)	40 (2.5)	0.79
Uterine rupture	8 (0.9)	10 (0.6)	0.24
Postpartum hemorrhage	48 (5.0)	90 (5.0)	0.37
Embolization	0	1 (0.1)	
Hysterectomy	0	0	
Ligature	0	1 (0.1)	
Transfusion	10 (1.2)	16 (1.0)	
Sulprostone	28 (3.2)	63 (4.0)	
Capitonnage	0	3 (0.2)	
Bakri balloon	0	2(0.1)	

380 *abnormal FHR
381 **preeclampsia, HELLP syndrom
382 ***arrest of labor, failure of induced labor
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384 **Table 4: Neonatal outcomes**

	Abnormal pelvic dimension at pelvimetry n=863 N (%)	Normal pelvic dimension at pelvimetry n=1611 N (%)	p	OR	aOR*
Composite criteria	20 (2.3)	27 (1.7)	0.26	1.39 (0.77-2.49)	0.93 (0.51-1.68)
Neonatal death	1 (0.1)	1 (0.1)	0.65		
Hypoxic ischemic Encéphalopathy	2 (0.2)	1 (0.1)	0.25		
5-min Apgar score < 4	6 (0.7)	4 (0.2)	0.09		
Materno-fetal infection	6 (0.7)	14 (0.9)	0.64		
Intubation > 24H	10 (1.2)	10 (0.7)	0.15		
umbilical pH < 7.10	40 (4.6)	29 (1.8)	< 0.001		
umbilical pH < 7.0	10 (1.2)	8 (0.5)	0.16		
Birth weight in grams (mean±SD)	3322±428	3460±498	< 0.001		
<2500 grams	26 (3.0)	43 (2.7)	0.62		
≥ 4500 grams	3 (0.3)	32 (2.0)	0.001		

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*adjusted for IUGR